Kelly KIM High Power AC Induction Motor Controller User's Manual

Devices Supported:

KIM4810	KIM4840E	KIM7210	KIM7240E
KIM4815	KIM4850E	KIM7215	KIM7250E
KIM4822		KIM7222	KIM7260E
KIM4830		KIM7230	

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Chapter 1 Introduction

1.1 Overview

This manual introduces the Kelly AC induction motor controllers' features, their installation and their maintenance. Read the manual carefully and thoroughly before using the controller. If you have any questions, please contact the support center of Kelly Controls, LLC.
Kellycontrols, LLC independently. It is suitable for fans, water pumps, air conditioner compressors, fridge compressor applications and etc. It uses high power MOSFET's, and PWM to achieve efficiencies of up to 99% in most cases. A powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to adjust parameters, conduct tests, and obtain diagnostic information quickly and easily.

Chapter 2 Features and Specifications

2.1 General functions

(1) Extended fault detection and protection. The LED flashing pattern indicates the fault sources.
(2) Monitoring battery voltage. It will stop driving if the battery voltage is too high and it will progressively cut back motor drive power as battery voltage drops until it cuts out altogether at the preset "Low Battery Voltage" setting.
(3) Built-in current loop and over current protection.
(4) Configurable motor temperature protection range.
(5) Current cutback at low temperature and high temperature to protect battery and controller. The current begins to ramp down at 90 ℃ case temperature, shutting down at 100 ℃.
(6) The controller keeps monitoring battery recharging voltage during regenerative braking, progressively cutting back current as battery voltage rises then cutting off regen altogether when voltage goes too high.
(7) Maximum reverse speed is configurable to half of max forward speed.
(8) Configurable and programmable with a host computer though RS232 or USB. Provide free GUI which can run on Windows XP/2000, Windows 7 and Vista (recommend using Kelly Standard USB To RS232 Converter).
(9) Provision of a +5 volt output to supply various kinds of sensors, including Hall effect type.
(10) 3 switch inputs which are activated by connection to Ground. Default to forward switch, brake switch and reversing switch.
(11) 3 analog 0-5V inputs that default to throttle input, brake input and motor temperature input.
(12) Pulsed reverse alarm output.
(13) Main contactor driver. Cutting off the power if any fault is detected.
(14) Current meter can display both drive and regen current. Save shunt.
(15) Configurable 12V brake signal input, instead of motor temperature sensor.
(16) Configurable motor over-temperature detection and protection with the recommended thermistor KTY84-130.
(17) Speed encoder input.
(18) The power supple of the controller is the standard battery voltage range.

Caution! ***Regeneration has braking effect but does not replace the function of a mechanical brake. A mechanical brake is required to stop your vehicle. Regen IS NOT a safety feature! Controller may stop regen, without warning, to protect itself or the battery(it won't protect you!).***

2.2 Features

1) Intelligence with powerful microprocessor.
2) Synchronous rectification, ultra low drop and fast PWM to achieve very high efficiency.
3) Electronic reversing.
4) Voltage monitoring on 3 motor phases, bus, and power supply.
5) Voltage monitoring on voltage source 12V and 5V.
6) Current sense on all 3 motor phases.
7) Current control loop.
8) Hardware over current protection.
9) Hardware over voltage protection.
10) Configurable limit for motor current and battery current.
11) Low EMC.
12) LED fault code.
13) Battery protection: current cutback, warning and shutdown at configurable high and low battery voltage.
14) Rugged aluminum housing for maximum heat dissipation and harsh environment.
15) Rugged high current terminals, and rugged aviation connectors for small signal.
16) Thermal protection: current cut back, warning and shutdown at high temperature.
17) Decelerating speed according to the brake rate when brake switch is active.
18) Decelerating speed according to the brake rate at reverse. Configurable reversing accelerating function.
19) Support three braking modes: release throttle braking, brake switch braking or reversing braking, analog signal variable braking. Configurable Decelerating Slip Frequency in configuration program.
20) Support three-level speed: free (the controller will stop output), forward, and backward.
21) Configurable high pedal protection: the controller will not work if high throttle is detected at power on.
22) Current multiplication: Take less current from battery, output more current to motor.
23) Easy installation: 3-wire potentiometer can work.
24) Remote fault code LED driver.
25) Current meter output.
26) Standard PC/Laptop computer is used to do programming. No special tools needed.
27) User program provided. Easy to use. No cost to customers.

2.3 Specifications

- Frequency of Operation: 16.6kHz.
- Standby Battery Current: < 0.5mA.
- 5V Sensor Supply Current: 40mA.
- Controller supply voltage range, PWR, 18V to 90V.
- Configurable battery voltage range, B+. Max operating range: 18V to 1.25*Nominal Voltage.

•Max output frequency can reach up to 255Hz.

•Standard Throttle Input: 0-5 Volts (3-wire resistive pot), 1-4 Volts (hall active throttle).

•Analog Brake and Throttle Input: 0-5 Volts. Producing 0-5V signal with 3-wire pot.

•Full Power Operating Temperature Range: 0 C to 50 C (controller case temperature).

•Operating Temperature Range: -30 C to 90 C , 100 C shutdown (controller case temperature).

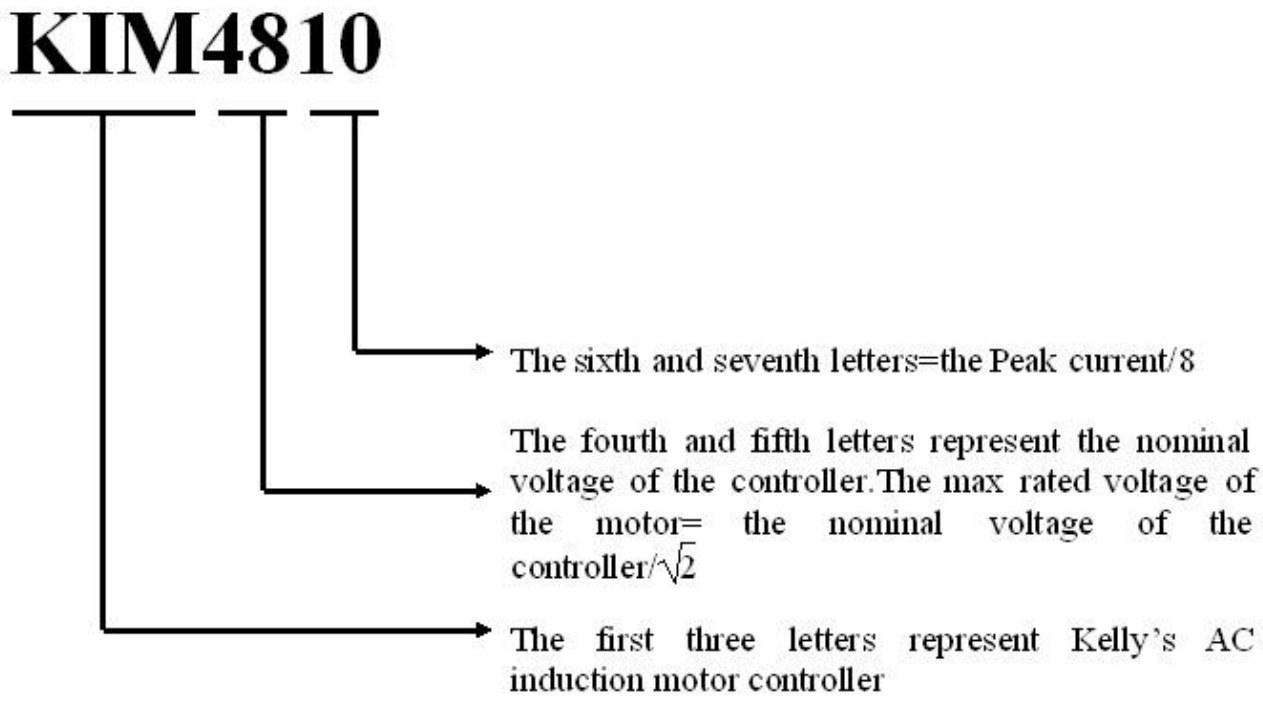
•Motor Current Limit, 1 minute: 80A-520A, depending on the model.

•Motor Current Limit, continuous: 48A-192A, depending on the model.

•Max Motor Current : Configurable.

2.4 Naming Regulations

The naming regulations of Kelly AC induction motor controllers:


KIM4810
The sixth and seventh letters=the Peak current/8
The fourth and fifth letters represent the nominal voltage of the controller.The max rated voltage of the motor= the nominal voltage of the controller/√2
The first three letters represent Kelly's AC induction motor controller

Chapter 3 Wiring and Installation

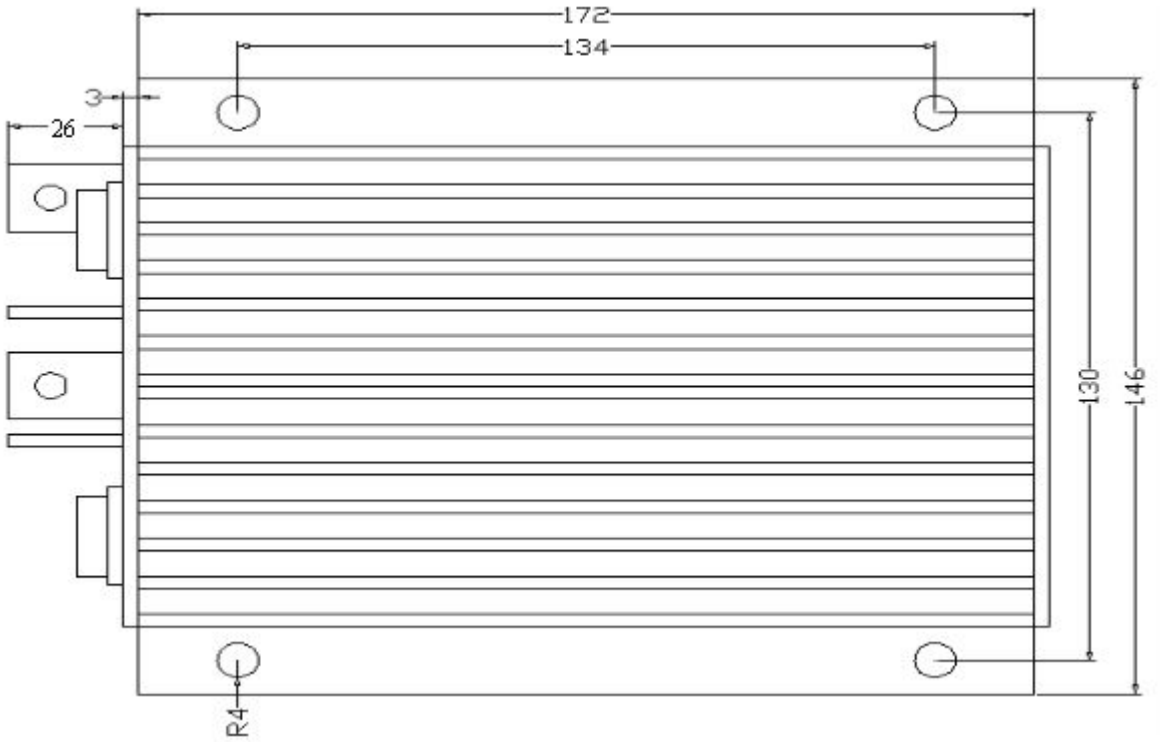
3.1 Mounting the Controller

The controller can be oriented in any position which should be as clean and dry as possible, if necessary, shielded with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with several screws. Applying silicon grease or some other thermal conductive material to contact surface will enhance thermal performance.

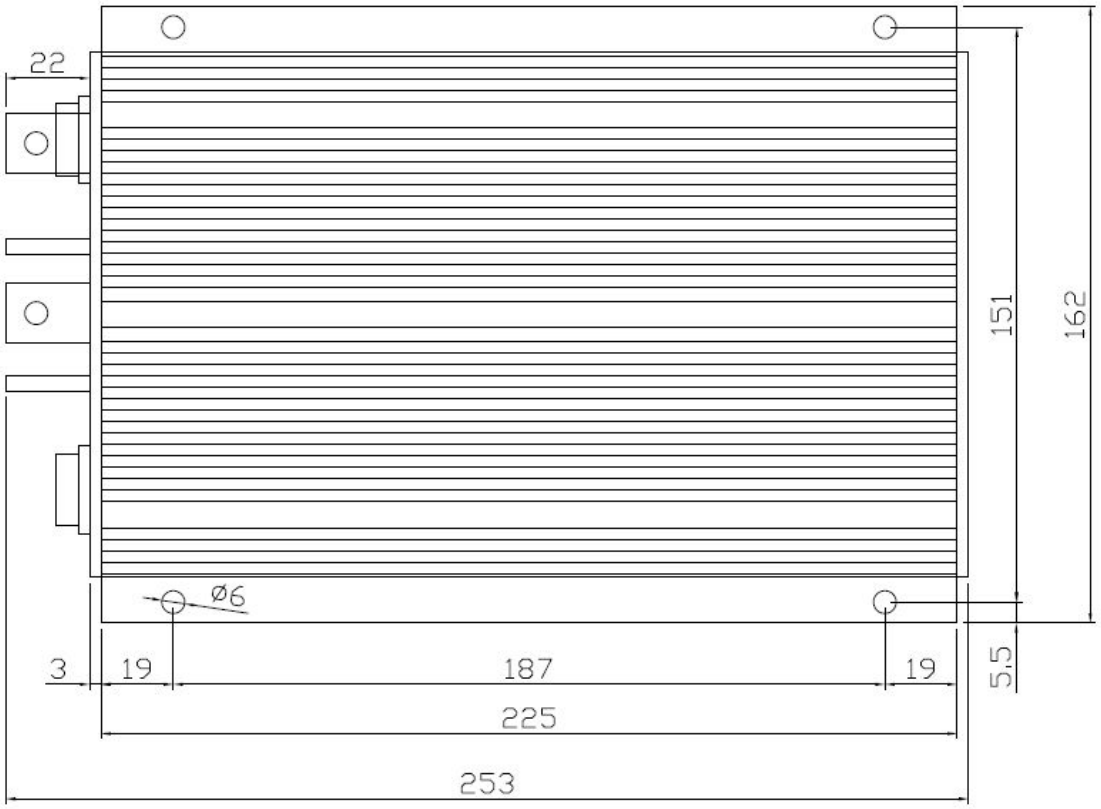
Proper heat sinking and airflow are vital to achieve the full power capability of the controller.

The case outline and mounting holes' dimensions are shown in Figure 1 and 2.



Height: 62 millimeters

Figure 1: KIM mounting holes' dimensions (dimensions in millimeters)



Height: 84 millimeters

Figure 2: KIM-E mounting holes' dimensions (dimensions in millimeters)

3.2 Connections

3.2.1 Front Panel of KIM Motor Controller:

Five metal bars and two plugs (J1, J2) in the front of the controller are provided for connecting to the battery, motor and control signals shown as Figure 3.

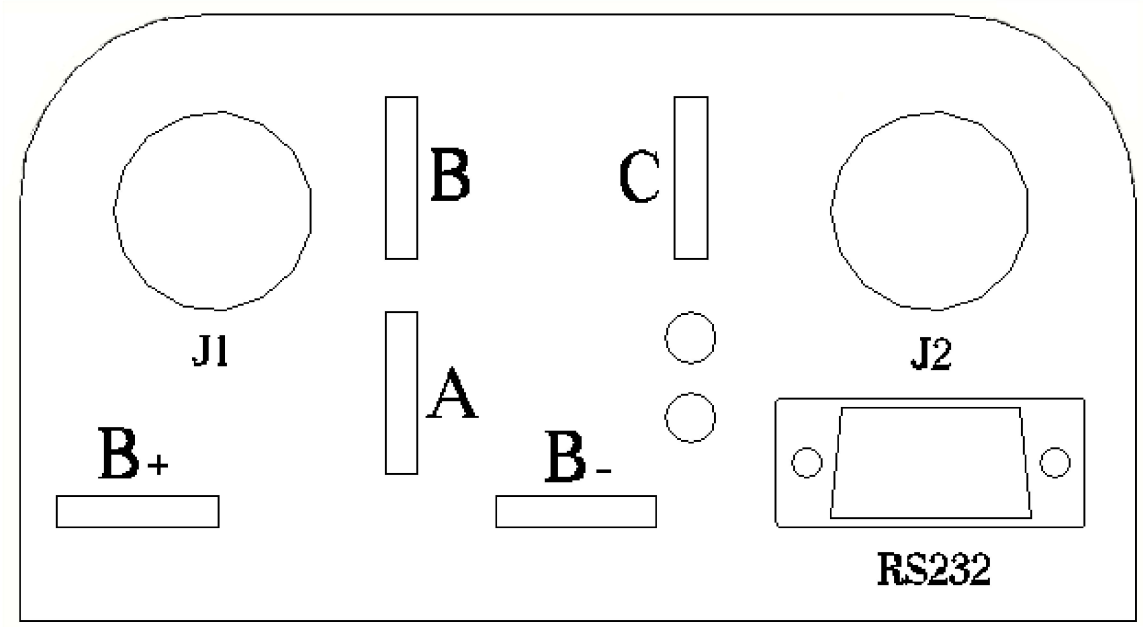


Figure 3: Front panel of KIM motor controller

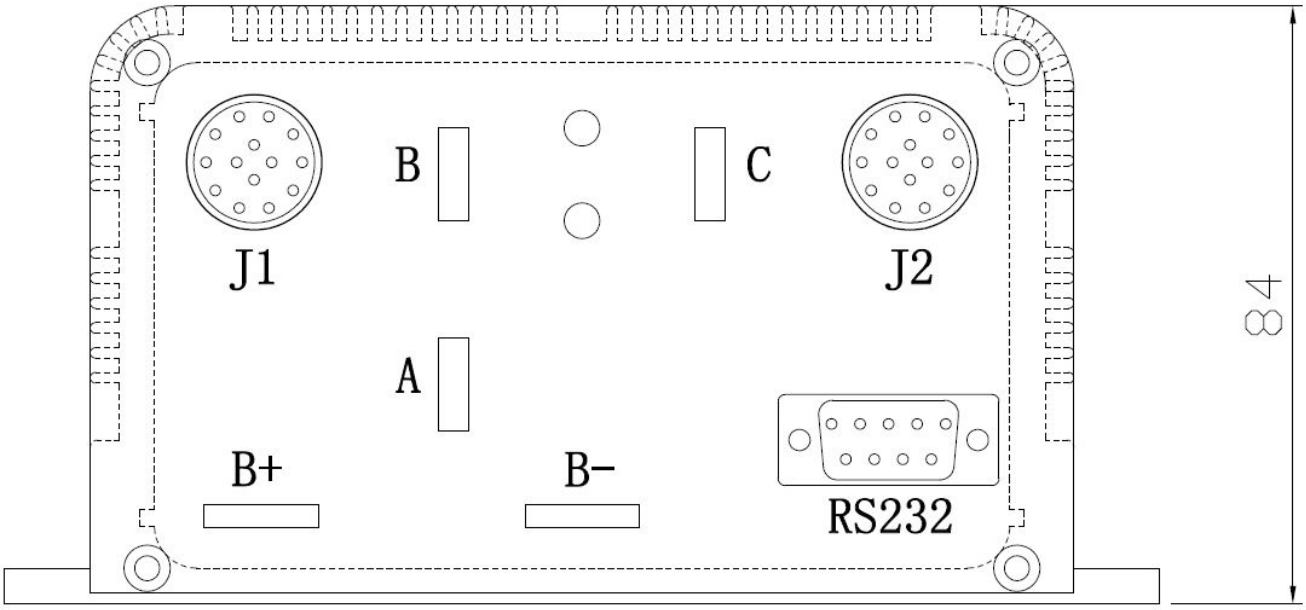


Figure 4: Front panel of KIME motor controller

B+: battery positive
B-: battery negative
A: Output U/1/A phase
B: Output V/2/B phase

C: Output W/3/C phase

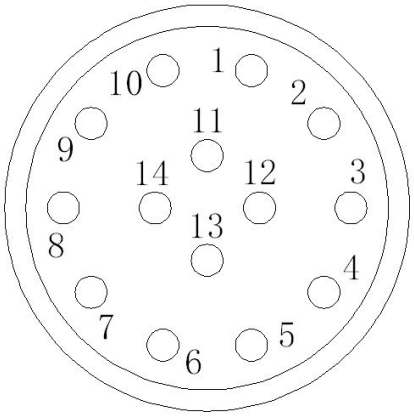


Figure 4: The connecting diagram of **J1** and **J2**

J1 Pin Definition

1- **PWR: Controller power supply (output).**
2- **Current meter. <200mA**
3- **Main contactor driver. <2A**
4- **Alarm: To drive reverse beeper. <200mA**
5- **RTN: Signal return**
6- **Green LED: Running indication**
7- **RTN: Signal return**
8- **RS232 receiver**
9- **RS232 transmitter**
10- **Reserved**
11- **Reserved**
12- **Reserved**
13- **RTN: Signal return, or power supply return**
14- **Red LED: Fault code.**

J2 Pin Definition

1- **PWR: Controller power supply (input)**
2- **RTN: Signal return, or power supply return**
3- **RTN: Signal return**
4- **12V high-level brake and motor temperature input.**
5- **Throttle analog input**
6- **Brake analog input**
7- **5V: 5V supply output. <40mA**
8- **Forward switch input**
9- **Reversing switch input**
10- **Brake switch input**
11- **Reserved**
12- **Reserved**
13- **Speed encoder signal input**
14- **RTN: Signal return**

Notes:

1. **All RTN pins are internally connected.**
2. **Two PWR pins, J1-1 and J2-1, are internally connected. It's recommended to use J1-1**

to supply peripherals like alarm and contactor. Twist peripheral wires with PWR is the preferred for EMC. Require external diode for alarm and contactor coil driver.

3. Kelly Ammeter positive connect to 5V power supply of controller, negative to J1-2.
4. Switch to ground is active. Open switch is inactive.

Caution:

- **Do not apply power until you are certain the controller wiring is correct and has been double checked. Wiring faults will damage the controller.**
- **Ensure that the B- wiring is securely and properly connected before applying power.**
- **The preferred connection of the system contactor or circuit breaker is in series with the B+ line.**
- **All contactors or circuit breakers in the B+ line must have precharge resistors across their contacts. Lack of even one of these precharge resistors may severely damage the controller at switch-on.**

3.2.2 Wiring of KIM Motor Controller

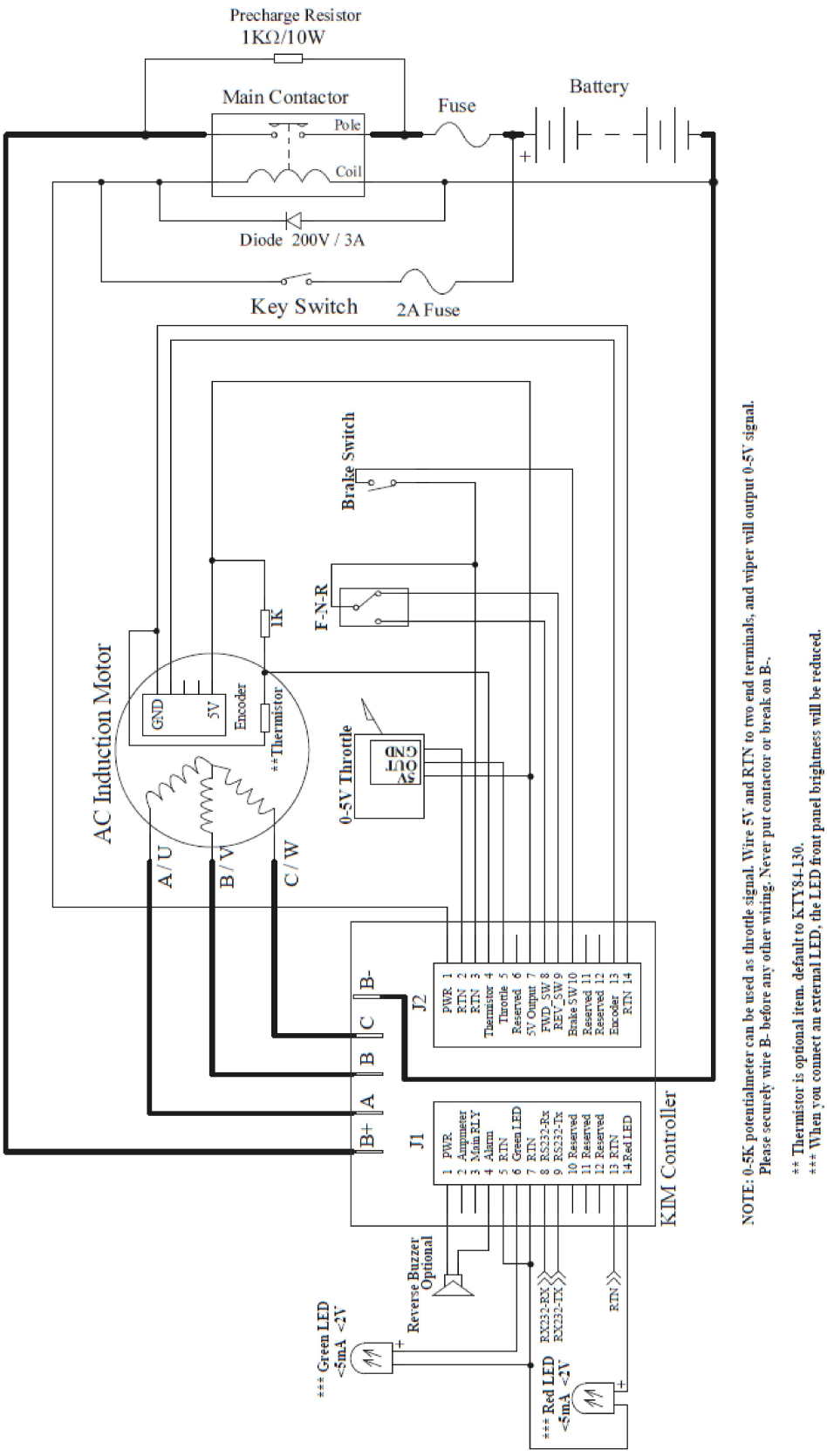


Figure 5: Standard Wiring for KIM Controller

3.2.3 Communication Port

A RS232 port is provided to communicate with host computer for calibration and configuration.

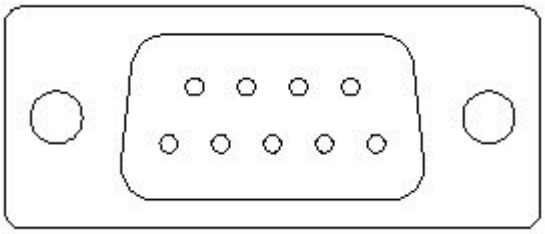


Figure 6: standard RS232 Interface

3.3 Installation Check List

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference as listed in Table 1.

Caution:

- **Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.**
- **Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.**
- **Make sure the PWR switch and the brake is off**
- **Use well-insulated tools.**

- Make sure the wire is connected correctly
- Turn the PWR switch on. The Green LED stay on steadily and Red LED turns off when the controller operates normally. If this does not happen, check continuity of the PWR and return.
- The fault code will be detected automatically at restarting.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Verify wiring or voltage and the fuse if it does not. The motor should run faster with increasing throttle. If not, refer to the Table 1 LED code, and correct the fault as determined by the fault code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good power.

Chapter 4 Programmable Parameters

KIM Configuration program allow users to set parameters according to the vehicle actual working environment so as to be at its best.

There are four types of programmable parameters: vehicle control parameters, throttle parameters, motor control parameters and controller parameters. The default parameters of the controller are not recommended for all applications. Make sure set the proper parameters before making any test to avoid danger.

4.1 Vehicle Control Parameters

(1) Power On High Pedal Disable
Value range: ON and OFF
Functional description: If click ON, the controller will detect the current pedal status at power up. If throttle got effective output, the controller will report fault and not operate.
Suggestion: Set according to the practical situation, factory default is ON.
(2)Releasing Brake High Pedal Disable
Value range: ON and OFF
Functional description: If click ON, the controller will detect the current pedal status when release the brake. If throttle got effective output, the controller will report fault and not operate.
Suggestion: Set according to the practical situation, factory default is ON.
(3) Reversing High Pedal Disable
Value range: ON and OFF
Functional description: If click ON, when reversing, the controller will decelerate the motor until to stop, then detect the current pedal status. If throttle got effective output, the controller will report fault and not operate; If click OFF, when reversing, the controller will decelerate the motor until to stop, then output reversely according to the current throttle value.
Suggestion: Set according to the practical situation, factory default is ON.
(4)Half Speed in Reverse
Value range: ON and OFF
Functional description: If click ON, the max reverse speed of the motor will be limited to half of the max forward speed.
Suggestion: Set according to the practical situation, factory default is OFF.
(5)Accelerate Rate
Value range: 1-64
Functional description: Determine how fast the throttle will accelerate, a higher value means a faster acceleration.
Suggestion: The greater the inertia of the system, the smaller accelerate rate will be, in order to avoid problems such as over current. Set according to the practical situation, factory default is 10.
(6)Decelerate Rage
Value range: 1-64
Functional description: Determine how fast the throttle will decelerate, a higher value means a

faster deceleration.
Suggestion: The greater the inertia of the system, the smaller accelerate rate will be, in order to avoid problems such as over current. Set according to the practical situation, factory default is 4.
(7)Brake Rate
Value range: 1-64
Functional description: When reversing or brake switch is active, the controller will decelerate according to brake rate, a higher value means a faster deceleration.
Suggestion: The greater the inertia of the system, the smaller brake rate will be, in order to avoid problems such as over current. The value of brake rate should be higher than that of deceleration rate. Set according to the practical situation, factory default is 10.
(8)Start-up Delay Time
Value range: 0-20
Functional description: When power is on, set delay time (the Value*80ms) to wait for stabilization of B+, a higher value means a longer delay time.
Suggestion: Set according to the practical situation, factory default is 0, means start-up delay time is 0ms.

4.2 Throttle Parameters

(1)Throttle Up/Down Rate
Value range: 0-100
Functional description: Pedal AD Sampling Frequency, a lower value means a shorter sampling period and a faster respond rate.
Suggestion: Set according to the practical situation, factory default is 30.
(2)Throttle Sensor Type
Value range: 3-wire resistive pot, hall active throttle
Functional description: Set throttle sensor type. If choose hall active throttle, the controller will be a short circuit or shut down when detect throttle signal <0.5V, or >4.5V.
Suggestion: Set according to the practical situation, factory default is 3-wire resistive pot.
(3)Throttle Effective Starting Point
Value range: 0-40%
Functional description: Set throttle effective starting point
Suggestion: Set according to the practical situation, factory default is 10%.
(4)Throttle Effective Ending Point
Value range: 60%-100%
Functional description: Set throttle effective ending point
Suggestion: Set according to the practical situation, factory default is 90%.
(5)Brake Sensor Type
Value range: No used, 3-wire resistive pot, hall active throttle
Functional description: Set brake sensor type. If choose hall active throttle, the controller will be a short circuit or shut down when detect throttle signal <0.5V, or >4.5V.
Suggestion: Set according to the practical situation, factory default is No Used.
(6)Brake Sensor Starting Point

Value range: 0%-40%
Functional description: Set brake sensor starting point
Suggestion: Set according to the practical situation, factory default is 10%.
(7)Brake Sensor Ending Point
Value range: 60%-100%
Functional description: Set brake sensor ending position
Suggestion: Set according to the practical situation, factory default is 90%.

4.3 Motor Control Parameters

(1)Nominal Voltage
Value range: Set according to the practical situation
Functional description: Determine the V/f curve; a higher value will damage the motor.
Suggestion: Conformed with the rated parameter of motor nameplate
(2)Nominal Frequency
Value range: No more than 255Hz, the adjusting accuracy is 1Hz.
Functional description: Determine the V/f curve
Suggestion: Conformed with the rated parameter of motor nameplate
(3)Nominal Motor RPM
Value range: Set according to the practical situation
Functional description: Set nominal motor RPM
Suggestion: Conformed with the rated parameter of motor nameplate
(4)Motor Poles
Value range: 2-16
Functional description: Used to calculate motor RPM
Suggestion: Conformed with the parameter of motor nameplate
(Motor Poles=Motor Pairs * 2)
(5)Encoder Pulses
Value range: 32-512
Functional description: Used to calculate motor RPM
Suggestion: Set according to the parameters provided by motor supplier, test the number of pluses in a cycle by oscilloscope if necessary.
(6)Max Output Frequency
Value range: No more than 255Hz, the adjusting accuracy is 1Hz.
Functional description: Set the max motor stator operating frequency
Suggestion: No less than [(Max Motor RPM * Motor Poles/120) + Max Accelerating Slip Frequency + Pull-out Slip Frequency]
(7)Max Motor RPM
Value range: No more than (65535 / Motor Poles) RPM, the adjusting accuracy is 1RPM.
Functional description: Set the max motor RPM at throttle 100% output. The actual max motor RPM may be lower than this value due to the limitation of the allowed max output frequency of the controller.
Suggestion: Set according to the practical situation, a higher value may damage the motor

bearings.
(8) Motor Top Speed
Value range: 30%-100%
Functional description: Limit the max speed to (The Value * Max Motor RPM)
Suggestion: Set according to the practical situation, factory default is 100%.
(9)Cut Off RPM
Value range: No more than (65535 / Motor Poles) RPM, the adjusting accuracy is 1RPM.
Functional description: Overspeed protection. When motor RPM is higher than the Value, the main contactor will cut out, and red LED report overspeed fault to avoid the danger.
Suggestion: Set according to the practical situation. The value should be about 10%-20% higher than the Max Motor RPM, otherwise it couldn't achieve protective effect and trigger errors.
(10)Min Output Voltage
Value range: 0-10V, the adjusting accuracy is 1V.
Functional description: Determine the starting point of V/f curve. A proper value can increase the torque at low speed, but a higher value will lower motor efficiency and make the temperature speed up quickly.
Suggestion: Set according to the practical situation, the factory default is 1.
(11)Min Output Frequency
Value range: 1Hz –10%*Motor Nominal Frequency, the adjusting accuracy is 0.1Hz.
Functional description: A proper value will make the motor start up smoothly and quickly.
Suggestion: Set according to the practical situation, the factory default is 1.5Hz. If the motor can not start up, please increase the Value.
(12)Max Accelerating Slip Frequency
Value range: No more than 25.5Hz, the adjusting accuracy is 0.1Hz.
Functional description: When the output frequency of the controller is lower than its nominal frequency, the actual motor accelerating slip frequency should no more than the Value in order to limit the motor peak current while speeding up.
Suggestion: Nominal Slip Frequency = [Nominal Frequency - (Nominal RPM * Motor Poles / 120)] Hz
(13)Max Decelerating Slip Frequency
Value range: No more than 25.5Hz, the adjusting accuracy is 0.1Hz
Functional description: When the output frequency of the controller is lower than its nominal frequency, the actual motor decelerating slip frequency should no more than the Value in order to limit the motor peak current while decelerating.
Suggestion: Set as 1.8 * Max Accelerating Slip Frequency, because the Current/Slip curve at deceleration is steeper than that at acceleration.
(14)Pull-out Slip Frequency
Value range: No more than 25.5Hz, the adjusting accuracy is 0.1Hz.
Functional description: When the output frequency of the controller is higher than its nominal frequency, the motor field will be weakened and torque be reduced. A higher value can increase the torque.
Suggestion: Set the same as Max Accelerating Slip Frequency
(15) Proportional Coefficient

Value range: 0.5-1, the adjusting accuracy is 0.01
Functional description: If set the value too low, the throttle and load respond in the system will be slower；if set the value too high, it will cause unsmooth drive or speed vibration.
Suggestion: Set according to the practical situation, factory default is 0.7
(16) Integral Coefficient
Value range: 1-20, the adjusting accuracy is 1.
Functional description: If set the value too low, the throttle and load respond in the system will be slower；if set the value too high, it will cause unsmooth drive or speed vibration.
Suggestion: Set according to the practical situation, factory default is 3.
(17)Max Motor Current
Value range: 20%-100%
Functional description: The max motor current is (The Value * Peak Current of the Controller).
Suggestion: (Motor Nominal Current * Overload Coefficient / Peak Current of the Controller) *100%, factory default is 100%.
(18)Max Decelerating Slip at Configuring Analog Signal
Value range: 10%-100%
Functional description: Max Decelerating Slip is

$$\frac{\text{Brake pedal current value}}{\text{Brake pedal max value}} * (\text{the Value} * \text{Max Decelerating Slip Frequency})$$

Suggestion:
(19)Max Decelerating Slip at Releasing Throttle
Value range: 10%-60%
Functional description: Max Decelerating Slip = the Value*Max Decelerating Slip Frequency
Suggestion: If set the value too low, the effect in decelerating braking is not obvious; if set too high, more current will recharged to battery that will cause controller overvoltage protection. The factory default is 20%.
(20)Max Decelerating Slip at Turning on Brake Switch
Value range: 10%-100%
Functional description: Max Decelerating Slip = the Value*Max Decelerating Slip Frequency
Suggestion: If set the value too low, the effect in decelerating braking is not obvious; if set too high, more current will recharged to battery that will cause controller overvoltage protection. The factory default is 40%.

4.4 Controller Parameters

(1) Under voltage
Value range: 18V-1.25*Nominal Voltage
Functional description: The controller will cut out at battery value lower than the setting so as to protect battery.
Suggestion: Set according to the practical situation
(2) Over voltage

Value range: 18V-1.25*Nominal Voltage
Functional description: The controller will cut out at battery value higher than the setting so as to protect battery and controller.
Suggestion: Set according to the practical situation
(3)Motor Temperature Sensor
Value range: ON or OFF
Functional description: If use motor temperature sensor and click ON, configurable Controller Stop Output Temperature and Controller Resume Output Temperature so as to achieve real-time protection on the motor.
Suggestion: Set according to the practical situation

Chapter 5 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller as this will void your warranty. However, periodic, exterior cleaning of the controller should be carried out.

The controller is a high powered device. When working with any battery powered vehicle, proper safety precautions should be taken that include, but are not limited to, proper training, wearing eye protection, avoidance of loose clothing, hair and jewelry. Always use insulated tools.

5.1 Cleaning

Although the controller requires virtually no maintenance after properly installation, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery, starting with battery positive.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil, resistor or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped down with a moist rag. Make sure that the controller is dry before reconnecting the battery.
- Make sure the connections to the bus bars, if fitted, are tight. To avoid physically stressing the bus bars use two, well-insulated wrenches.

5.2 Configuration

You can configure the controller with a host computer through either an RS232 or USB port.

- Disconnect motor wiring from controller.
- Do not connect B+, throttle and so on. The controller may display fault code, but it doesn't affect programming or configuration.
- Use straight through RS232 cable or USB converter provided by Kelly to connect to a host computer. Provide >+18V (either J2 pin1 or J1 pin1) to PWR. Wire power supply return to any RTN pin.

Download the free configuration software from：

http://www.kellycontroller.com/support.php

Caution:

- **Make certain that the motor is disconnected before trying to run the Configuration Software!**
- **Configuration software will be regularly updated and published on the website. Please Update your Configuration Software regularly. You must uninstall the older version before updating.**
- **When setting "Hall Sensor Type" in GUI, do not use "Auto-Check". This has been deleted from the newer configuration software versions.**

Table 1: LED CODES

Green LED Codes

LED Code	Explanation	Solution
Green Off	No power or switched off	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	Normal operation	That's great! You got solution!
Green & Red are both On		1. Software still upgrading. 2. Supply voltage too low or battery too high 3. The controller is damaged. Contact Kelly about a warranty repair.

Red LED Codes

LED Code		Explanation	Solution
1,2	¤ ¤¤	Over voltage error	1. Battery voltage is too high for the controller. Check battery volts and configuration. 2. Regeneration over-voltage. Controller will have cut back or stopped regen. 3. This only accurate to ± 2% upon Overvoltage setting.
1,3	¤ ¤¤¤	Low voltage error	1. The controller will clear after 5 seconds if battery volts returns to normal. 2. Check battery volts & recharge if required.
1,4	¤ ¤¤¤¤	Over temperature warning	1. Controller case temperature is above 90℃. Current will be limited. Reduce controller loading or switch Off until controller cools down. 2. Clean or improve heatsink or fan.
2,1	¤¤ ¤	Motor did not start or Motor RPM is too slow	No signal is detected after 2 seconds from starting. 1. Motor locked rotor，low starting torque. Please set a higher Min Motor Voltage. 2. The encoder is damaged or wired incorrectly. Replace the damaged encoder or check the wiring.
2,2	¤¤ ¤¤	Internal volts fault	1. Measure that B+ & PWR are correct when measured to B- or RTN. 2. There may be excessive load on the +5V supply caused by too low a value of Regen or throttle potentiometers or incorrect wiring. 3. Controller is damaged. Contact Kelly about a warranty repair.
2,3	¤¤ ¤¤¤	Over temperature	The controller temperature has exceeded 100℃. The

			controller will be stopped but will restart when temperature falls below 80℃.
2,4	¤¤ ¤¤¤¤	Throttle error at power-up	1. Throttle signal is higher than the preset 'dead zone' at Power On. Fault clears when throttle is released. 2. Set throttle model as "Hall Active" throttle in GUI if you use that throttle type.
3,1	¤¤¤ ¤	Frequent reset	May be caused by over-voltage, bad motor intermittent earthing problem, bad wiring, etc.
3,2	¤¤¤ ¤¤	Internal reset	May be caused by some transient fault condition like a temporary over-current, momentarily high or low battery voltage. This can happen during normal operation.
3,3	¤¤¤ ¤¤¤	Hall throttle is open or short-circuit	When the throttle is repaired, a restart will clear the fault.
3,4	¤¤¤ ¤¤¤¤	Non-zero throttle on direction change	Controller won't allow a direction change unless the throttle or speed is at zero. Fault clears when throttle is released.
4,1	¤¤¤¤ ¤	Braking or speed deceleration Over-voltage	The controller will stop regen if battery voltage is higher than configured limit or detects over-voltage at power up. The voltage threshold detection level is set during configuration.
4, 2	¤¤¤¤ ¤¤	Controller has been locked	The controller is locked while leave factory. Please set proper parameters via Kelly Configuration Program to ensure safety operation of the controller and motor. The controller will be unlocked after programming.
4, 3	¤¤¤¤ ¤¤¤	Motor over-temperature	Motor temperature has exceeded the configured maximum. The controller will shut down until the motor temperature cools down.
4, 4	¤¤¤¤ ¤¤¤¤	Motor overspeed	1. The actual motor RPM has exceeded the configured maximum. 2. Cut Off RPM of the motor. A restart will clear the fault.
The Red LED flashes once at power on as a confidence check and then normally stays Off. "1, 2" means the Red flashes once and after a second pause, flashes twice. The time between two flashes is 0.5 second. The pause time between multiple flash code groups is two seconds.			

Contact Us:

Kelly Controls, LLC

Home Page:
http://www.KellyController.com

E-mail:
Support@KellyController.com

Phone:
(01) 224 637 5092